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Draft
Diversion Effects on Fish Populations.
CALFED Alternatives Evaluation for Striped bass.

Introduction- Evaluation Team and Process:

The CALFED task of evaluating diversion effects on fish was divided into species sub-committees. The striped bass subgroup met twice and evaluated the diversion impacts of the alternatives based on information provided in the CALFED Phase II report and in operation studies provided.

The striped bass evaluation is based on a review by biologists with knowledge of the striped bass population and historic relationships of egg and larva distribution and abundance, young-of-the- year abundance, and adults in relation to estuarine conditions and historic changes. Participants on the work team are Stephani Spaar, Department of Water Resources, David Kohlhorst, Lee Miller, Kevan Urquhart, and Don Stevens, Department of Fish and Game. Elise Holland, Bay Institute was a member of our team but was unable to attend meetings when the matrices of diversion effects were developed. This report is the result of the interactions of this group.

Methods:

We completed matrices for: existing conditions, no action conditions (projection of increased demand on existing facilities), common programs, diversion alternatives 1, 2, and 3 and full restoration. We adopted a scale of -5 to +5 to express the relative impact of effects identified in the matrix as major components that would affect striped bass in relation to water diversions. Evaluations were based on qualitative assessments of the degree to which operations impact the population. After the matrix scoring was completed we assigned relative weight factors to each component of the matrix. We also limited the fall- winter periods to combinations of months which became self-weighting in the process since striped bass during these periods tend to be less vulnerable to diversions.

Existing conditions are the diversions as operated currently with the Bay-Delta Accord in place. An evaluation of full restoration conditions relative to the existing conditions and alternative choices was made to assess the extent to which the striped bass population would be restored with the proposed alternatives. All matrices were completed using the CALFED operations studies provided. This was a judgmental process with no striped bass modeling, data analysis, or quantitative assessments made because time constraints did not permit more rigor. In many cases we cannot be certain how the population might respond to the new conditions being proposed

Results

The following questions were evaluated.

1 Which species, populations, and life stages are most sensitive to diversion effects under no action and alternatives 1, 2, and 3? When and where are they most affected?

No Action.

Striped bass eggs and larva and juveniles are the life stages directly impacted by water diversions in the Delta during the first year of life from April through the fall and sometimes the winter. The impact on eggs and young fish up to 38 mm mean length occurs from April to July with further impacts on larger juveniles through the summer and fall. These impacts have been demonstrated for existing conditions (DFG 1992, Stevens et al, 1985) and would continue under the No Action Alternative. Total exports under the No Action Alternative during the spawning and nursery season are roughly the same as average existing conditions (CALFED 1998, Appendix A, E). Although average annual exports for the No Action are 6.5 percent higher than existing exports, most of the increase occurs from August to March. The added impact on striped bass during this period tends to be relatively small in wet years and greater in dry and critical years because of longer fish residence time in the Delta when flows are low.

It is unclear whether or not increased exports over current levels would further deplete the population of young striped bass in the Delta, since they may already be nearly depleted there under current export levels in dry and critical years. Under current conditions the population is likely to continue to decline in the absence of a hatchery stocking program (Striped Bass Management, Endangered Species Act Section 10 Conservation Plan). In recent years, young striped bass abundance has remained low despite higher than average delta outflows and low export rates, which are conducive to strong year classes. The most apparent cause is the continuing decline in egg production caused by average lower recruitment since the 1970's due to entrainment losses and higher mortality rates for adults in recent years.

Alternative 1.

Under Alternative 1, we expect continued entrainment of eggs, larva, and juveniles in the south Delta. However, as the cross channel gates remain closed through the spawning season from April to June for winter-run chinook salmon protection, this would reduce the diversion of Sacramento River striped bass eggs and larvae in comparison to periods when the cross channel gates were open in years before the winter-run criteria went into effect. As in the past, eggs and larvae would move across the Delta from the Sacramento River through Georgiana and Three-mile sloughs and some would be entrained at the export facilities.

Alternative 2.

Under alternative 2, increased numbers of eggs and larvae would be diverted and entrained from the Sacramento because fish screens at the Hood diversion would be inadequate to screen these stages. At the Clifton Court diversion, eggs, larvae, and juveniles would be continue to be entrained; some juveniles should be salvaged.

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Adults would be affected because they would be attracted by the high proportion of Sacramento water flow in the Mokelumne River this channel and they would be trapped behind the fish screen at Hood. There is no known way of passing striped bass over such structures, although some way of passing adults around the screen might be found, depending on the screen design. If trapped adults spawn in the Mokelumne River, most of their progeny would be transported to the pumps and entrained. Thus, even if they spawn, these adults would not provide progeny to maintain the population. It is unknown what proportion of the population might use this channel to attempt to access the Sacramento River. If flows diverted at Hood are a large proportion of the Sacramento flow, as might occur in dry years, more fish might be attracted to the Mokelumne as a corridor to the spawning grounds. Striped bass tagged in the San Joaquin River are commonly recaptured within a few weeks from the Sacramento River above Sacramento, but it is unknown which pathways from the San Joaquin to the Sacramento River are most important.

Alternative 3.

This alternative would divert eggs and larvae from both rivers as well as juveniles from the San Joaquin, depending on operations. If the diversion is reduced at Hood during the striped bass spawning season, then diversion of eggs and larva from the Sacramento River would be reduced. Adults would not be affected because the facility is isolated and screened so adults spawning in the Sacramento River would be able to pass the facility intake in both directions without being adversely affected.

When diversion occurs in the south Delta, entrainment would continue for eggs, larvae, and juveniles from the San Joaquin River and through other Delta channels. However, since QWEST flows would be much improved over existing conditions and less water would be diverted from the south Delta we expect less entrainment of striped bass.

2. Can diversion effects in the South Delta be offset by habitat improvements and other common program actions?

Striped bass can use various habitats to rear, including shallow water. Any improvements in habitat in Suisun Bay or in other areas secure from entrainment effects could help striped bass; however, there is no way to determine, a priori, if such habitat change would offset entrainment losses and indirect mortality from transport flow reductions on the Sacramento River.

Reduction in toxicants may improve striped bass survival, but toxicants have not been identified as a major controlling factor for the striped bass population. Hence, population increases resulting from this program would likely be small.

Some common programs may adversely affect striped bass and other fish populations if nutrients and turbidity are reduced. For example, if nutrients, carbon input, and primary production are decreased this would reduce the food supply for fish. Turbidity reduction could result in increased predation on young fish.

3. To what extent can alternatives 1, 2, and 3 offset diversions effects as presently configured?

All three alternatives screen the intake to Clifton Court Forebay which reduces predation losses now occurring in Clifton Court. The No Action choice would continue the predation losses.

Alternative 1.

Alternative 1 offers marginally improved conditions for striped bass compared to existing conditions by elimination of predation on young striped bass in Clifton Court Forebay. However, striped bass in the Delta would still be exposed to large potential entrainment losses due to screen inefficiencies, handling mortality, and indirect losses. This alternative maintains flows in the Sacramento River below Hood as occurs under present conditions providing for faster transport of striped bass out of the river and into the lower river and Suisun Bay than either Alternatives 2 or 3. Striped bass survival between egg and larva stages increases with increased river flow (IESP 1994).

Alternative 2.

Alternative 2 would decrease the diversion of striped bass in the South Delta by creating more positive net flows in the San Joaquin River. Operation studies indicate that net San Joaquin flows at Antioch would be positive for all months of the year and in April-July would be about double the No Action conditions or conditions under Alternative 1. However they are still small relative to the tidal volume. On average, reverse flows would no longer occur on the San Joaquin River (based on operations studies: QWEST, years 1921-1994, Flow at Antioch,1975-1991). However, as the Hood diversion reduces transport flows for larvae, would trap significant number of adults behind a fish screen, and entrain large numbers of eggs and larvae from the Sacramento River, this alternative would provide worse conditions for striped bass than existing diversion conditions. The extent of impact is uncertain given the unknowns associated with the above. How these facilities are operated to minimize impacts during the spawning season is important.

Alternative 3.

The use of Alternative 3 in lieu of existing conditions for times of the year other than the striped bass spawning period would greatly reduce the entrainment losses now occurring in the south Delta. Additionally, because it is an isolated facility, it would not attract and trap adult fish behind a fish screen at Hood. The diversion of eggs and larvae during the spawning season and reduced transport flows would be detrimental to striped bass. If the facility were operated to minimize such diversions when striped bass spawn and south Delta diversions were also minimized during the spawning and nursery period, this would provide greatly improved conditions for striped bass. Positive flows in the San Joaquin River would be good for striped bass spawning in the San Joaquin River; it would move them west to better nursery conditions and away from entrainment. This alternative scored highest in the matrix exercise.

4. To what extent can diversion effects be offset by modifications to the alternatives or by operational changes?

How the diversion is operated and the timing of diversion is very important for striped bass. Reductions in April to July exports in the south Delta and of diversions at Hood during the striped bass spawning season would greatly lessen impacts on the population. Under both Alternatives 2 and 3, minimizing the Hood diversion during striped bass spawning pulses would have a positive effect by keeping eggs and larvae in the river and providing adequate downstream transport flows

5. What is the risk and chances of success of species recovery for each alternative?

The striped bass population has been declining. The adult population is affected by reduced recruitment as a result of early life stage losses without sufficient density-dependent survival (compensation) to maintain the numbers of adults that were historically present. Although some compensation is apparently occurring between the young-of-the-year abundance and recruitment at age 3, the population of adults, which numbered 1.8 million in the early 1970's, has declined to about 700,000 presently. Recovery cannot occur under the No Action Alternative. Alternatives 1 and 2 appear to exacerbate present striped bass population stressors. Alternative 3 still falls short of full restoration to historic population levels (see matrix page 8); largely because water demands exclude achievement of full restoration conditions. Alternatives 3, if operated in a manner which minimized entrainment of young striped bass, provides the best opportunity for some restoration of the population.

Additional technical questions were posed and the responses are included here:

1. What increment of protection or improvement for fish species will be provided by other programs such as the Central Valley Project Improvement Act, biological opinions, etc.?

   This is difficult to evaluate since the amount of water allocated to fish restoration efforts has not been firmly committed to any striped bass restoration scenarios.

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2 What degree of benefit and impact will the common programs provide?

The common programs will likely provide some benefits but these are difficult to quantify. Increasing the amount of marsh habitat for nursery areas adjacent to Suisun Bay and in San Pablo Bay would increase survival of young striped bass. Reducing point and non-point sources of toxic chemicals and metals would improve conditions for fish but because such impacts are not now quantified it is difficult to be certain of the degree of benefit. Toxicants have not been identified as a factor which determines population size. As mentioned previously, reduction of organic input and decreasing turbidity may adversely effect fish production.

3. What are the direct and indirect effects on fish populations resulting from each alternative and what is the expected response of the populations to these effects?

Covered in answers to questions 1-6 in the first section above.

4. What Sacramento River flow is required below a Hood diversion to protect salmon, striped bass and delta smelt?

Transport flows to move striped bass into the estuary apparently are very important. When large numbers of striped bass eggs and larva are moving down the Sacramento River, diversion should stop or be minimized to reduce the impact of entrainment and to assure sufficient transport to promote the survival of larvae. Diversion which caused either no flow or reverse flows in the Sacramento River below the diversion intake would likely be very detrimental to young striped bass.

5. What survival rate can be expected for striped bass eggs and larvae and delta smelt passing through Sacramento River screen and pumps in Alternative 2?

We would expect that most striped bass eggs and larvae would be entrained with water diverted at Hood and channeled to the pumping plants and therefore survival would be very low. Some would likely be caught in the tidal volume and move back and forth in the San Joaquin River and of these some might avoid entrainment by moving beyond the influence of the pumps depending on San Joaquin River net flows. However net flows are low relative to the tidal volume as previously indicated which suggests that residence time within the influence of the pumps will be long. Modeling of the hydrodynamics might be helpful to estimating the proportion of striped bass larvae and juveniles lost to pumping.

6. Should there be a screen on the Sacramento River intake of Alternative 2?

A screen for striped bass eggs and larvae, if feasible, would likely be very expensive and difficult to maintain in a debris free state. A screen should be resorted to only if flexibility in operations cannot accomodate striped bass spawning.

7. What are the logical stages for a preferred alternative?

Alternative 3 is the preferred alternative for striped bass. It is not clear how this could be built in stages based on biological considerations.

8. What is the range of biological criteria that should be considered in operations of the three alternatives?

We are not sure what criteria are expected here.

Alternative 1. Fish screens need to be improved and handling and trucking mortality greatly reduced.

Alternatives 2 and 3. Reduction in diversion during the spawning season on the Sacramento River. Maintenance of transport flows during the spawning season.

Uncertainties

There are many uncertainties in this evaluation, both large and small. Even with further data exploration, there is much that would remain speculative in our assessment of potential benefits and detriments. First, there is the uncertainty regarding how much striped bass entrainment losses will be reduced and access to nursery areas enhanced with positive downstream flows rather than reverse flows in the San Joaquin River. Is it a little or a lot? Similarly, when Sacramento River flows necessary for larvae transport are greatly reduced below Hood, how much will this affect the survival of striped bass left in the river? At this location, transport flows obviously become more important in years of low inflow. The proportion of the adults that would use the Mokelumne as a migration corridor to the Sacramento River spawning ground is unknown. If that proportion is small, it will have a minor effect; if large it will have a major negative impact.

Additional Issues

References

Department of Fish and Game. 1992. A re-examination of factors affecting striped bass abundance in the Sacramento-San Joaquin estuary. WRINT-DFG-Exhibit 2. Entered by the California Department of Fish and Game for the State Water Resources Control Board 1992 Water Rights Phase of the Bay-Delta Estuary Proceedings. 59 p.

IESP. 1994. 1992 Annual Report. Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary.

Stevens, D. E., D. W. Kohlhorst, L. W. Miller, and D. W. Kelley. 1985. The decline of striped bass in the Sacramento-San Joaquin Estuary, California. Transactions of the American Fisheries Society 114:12-30.

Appendix I. Matrices